This accords with the result (2) already found for the mean distance of the earth from the sun. In a paper on the "Intensity of the Sun's Heat and Light" (Smithsonian Contributions to Knowledge, IX.), L. W. Meech calls $\frac{2\pi}{a^2 n \sqrt{1-e^2}}$ "the sum of the intensities during a complete revolution." In this expression n is the mean daily motion and equals $\frac{\pi}{T}$. Substituting $\frac{\pi}{n}$ for T and making μ equal to 1 in (4), the latter reduces to Meech's formula.

3. "If any two chords of the earth's orbit, as AX and BY, be drawn through the sun, S, the amount of heat received in passing over the arc AB equals the amount received in passing over XY." (p. 82). Samuel Haughton ("New Researches on Sun-Heat," 1881) proves by another simple application of Kepler's second law that the quantity of heat received by the earth in a given time is proportional to the angle described in that time by the radius-vector. For

$$r^2\, d\theta = 2c\, dt,$$
$$d\theta = \text{increment of true anomaly},$$
$$\frac{dt}{r^2} = \frac{d\theta}{2c} = \text{heat in the time } dt.$$

This is but a mathematical translation of the argument given by Herschel in "Outlines of Astronomy," 5th ed., § 368 b. The statement made on page 82, "Cause of an Ice Age," is verified by an employment of Haughton's expression. For since

$$dh \propto \frac{dt}{r^2}, \qquad dh \propto \frac{d\theta}{2c}; \text{ hence}$$
$$h \propto \frac{\theta_2 - \theta_1}{2c}. \text{ Now } ASB = XSY = \theta_2 - \theta_1,$$

and the proposition is established. The law that "the amount of heat received in any given interval is exactly proportional to the true anomaly described in that interval" appears to have been first published by Lambert in his "Pyrometrie," 1779.

4. "The total heat received by the earth from equinox to equinox is equal to that received while completing its journey around the remaining part." (p. 83). The preceding demonstration does not involve the inclination of the chords to each other, neither does it involve the direction of either chord. Hence we may make X coincide with B and Y with A, and let the one resulting chord be the line of equinoxes, and the proposition follows.

5. "If δ be the sun's declination the amounts of heat received by the Northern Hemisphere and the Southern are to each other as $1 + \sin\delta$ to $1 - \sin\delta$." (p. 175). Draw a circle representing a section through the centre of the earth (regarded as a sphere). Let the horizontal diameter produced represent the celestial equator projected in a right line EE'. Through the centre of the circle draw AA', making an angle δ with EE'. AA' will be the axis of the cylinder of heat-rays falling upon the earth when the sun's declination is δ. Draw a diameter, DD', perpendicular to AA', and at the upper extremity of DD' draw an element, TT', of the cylinder. To this draw a parallel, CC', intersecting EE' at the circumference of the circle. TT' and CC' evidently include the portion of the cylinder falling on the Northern Hemisphere. If $2R$ is the length of the diameter, the perpendicular distance between TT' and CC' is seen to be $R + R\sin\delta$. Hence if $\frac{2H}{r_0^2}$ be the quantity of sun-heat falling perpendicularly on an area equal to the section of the earth at the mean distance r_0 from the sun in the unit of time, $\left(\frac{R + R\sin\delta}{2R}\right)\frac{2H}{r_0^2}$ is the part falling on the Northern Hemisphere, while the remainder, $\left(\frac{R - R\sin\delta}{2R}\right)\frac{2H}{r_0^2}$, falls on the Southern Hemisphere. These amounts are to each other as $1 + \sin\delta$ to $1 - \sin\delta$.

One or two other propositions will be discussed in a subsequent article.

ON A PHYSIOLOGICAL CLASSIFICATION OF THE OPHIDIA — WITH SPECIAL REFERENCE TO THE CONSTRICTIVE HABIT.

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THE writer would be the last to suggest a classification of any group of animals whatsoever based upon physiological data alone. Function, unless correlated with definite variation of structure, is never to be depended upon as a means of establishing specific differences. In illustration of this, one has only to cite the numerous examples of change of function, not simply within historic times, but even within the memory of living man, owing to variation in the environment of the creatures themselves. Witness the Kea, or New Zealand parrot, and the baboon of South Africa, both of which have become carnivorous since the introduction of sheep into this region; the bees of England, which, in certain districts, have within the last twenty years become frugivorous; and certain colonies of bats, inhabiting the islands of the Gulf of Paria in Trinidad, which have of late years taken to fishing, and have in consequence abandoned their nocturnal habits, and are now strictly diurnal beasts of prey. It is true that in certain isolated cases a change of function is followed by very slight variation of physical structure. In that of the domestic cat the intestine has certainly become elongated, and has probably undergone a further process of elongation in consequence of its less purely carnivorous diet; in particular, the duodenum has become more extended within recent centuries, if one may judge from analogy when comparing the creature with its wild prototypes.

In the case, however, of serpents, the family resolves itself into three groups so naturally in accordance with the manner in which they take their food, as to suggest the justification of a natural grouping founded on this basis.

If we had a specimen of every kind of snake before us, and could watch them in the act of feeding, we should see that they perform this process in three different manners. The majority, numbering probably 1,000 or 1,200 out of the 1,800 known species, simply catch the creatures on which they prey by the prehension of their jaws and long curved teeth, and work them gradually into the gullet on what we may call general principles.

A great disproportion exists between the size of the captor and of the captive. If the serpent be very much larger than the animal which it swallows, the latter is probably engulfed alive; but if, as is commonly the case, the captive is of large diameter proportionately to the œsophagus of the serpent, it is suffocated or crushed to death in the act of swallowing. As may be expected, the serpents that feed in this manner are such as live on what may be termed soft food, — frogs, lizards, fish, or other snakes.

But with the remainder we find two special provisions for the slaughter of the prey previous to deglutition — provisions so remarkable as to place the possessors in an entirely different category to the preceding. In one of these, and by far the smaller of the two subdivisions, numbering probably not more than 220 species altogether, or about one-eighth of the whole number of snakes, we find the death of the prey is encompassed by the injection of a morbific fluid, the venom. That this in the majority of cases serves as ammunition for the destruction of the captive cannot be doubted; but whether this is the primary reason why these creatures are gifted with venom is not so certain, seeing that in many species it probably comes very little into play for this purpose — e. g., in the sea snakes, in which the fangs are so short that the fish on which they live are scarcely scratched by them, and even in the great Ophiophagus, the snake-eating snake of India, whose natural diet consists of animals in which the circulation is so slow and vitality so sluggish as serpents that they are certainly swallowed before any poison could have time to work its effect upon them. In all probability the primary office of this remarkable fluid is to act as a digestive, it having been found by experiment that albumen, pieces of hard-boiled egg, etc., dissolve in this quite as readily as in the gastric juice of any flesh-eating animal. The writer has further established by his own experiments that small animals which have been sub-

mitted to the fangs of rattlesnakes, and other large viperine serpents are very much more quickly digested, not only by snakes, but by toads and other carnivorous reptiles and even mammalia, than pieces of meat or animals of corresponding species which have not been so treated.

There can be very little doubt that this morbific fluid, this venom, is a product of a recent evolution. The venom gland, although large, is distinctly one of the salivary glands in structure, one of the racemose group, very little altered in appearance from that which secretes the ordinary saliva, the venom being in fact an abundant saliva, and containing some toxic element the nature of which has not yet been distinctly ascertained, in addition to the ordinary salivary products. There is probably no other instance in nature of the enormous disproportion of change of function when compared with change of structure as obtains in the venomous fluid of the gland of a poison-bearing snake, unless indeed it be the function of the brain of man when compared with that of animals almost equal to him in complexity of cerebral structure.

There remains, however, a third group of serpents, gifted with the power of killing their prey before deglutition. These, which number possibly 400 or 500 species (the number not being accurately ascertained owing to absence of observation of living specimens), may be termed the Constrictive Group ; and although no such physical distinction can be drawn between these and the ordinary or Colubrine snakes on structural grounds, as is at once apparent between the latter and the venomous group, yet the process of feeding is so entirely different, as to suggest the feasibility of establishing such a difference, by careful dissection. With these snakes the prey is slain at the moment of the seizure, by constriction, by being wrapped within the folds of the body and crushed to death ; and this process is so remarkable in its vigor and in its rapidity, that it is impossible to imagine the creatures destitute of specially developed, if not specially supplied, muscles for this purpose.

This group includes not only the great Anaconda of tropical America, the very much smaller Boas of that region, as well as the Tree Boas, and the Pythonoid snakes of Africa and the East Indies, but very many smaller species as well. The black snake of North America is indeed distinctively named Coluber Constrictor ; but there are very many other species manifesting this peculiarity which have as yet obtained no such distintive recognition, such as the Blue Racer of the States, the Saw-marked snake of South America, and the largest of the European serpents, the beautiful four-rayed Elaphis of Italy and Greece, which occasionally attains a length of six feet, and is capable of swallowing a large rat.

It is just possible that this power of constriction may have been acquired recently, like the venom of the poison-bearing snakes. Unfortunately, paleontology affords no evidence upon this point. We know very little of the evolution of the Ophidia. Fossils are very scarce; and although some of them, such as the noted specimen from the London Clay, suggest serpents of large size, and therefore presumably constrictors, we know nothing beyond what is suggested by mere inference as to whether they were gifted with venom, or had this property of constricting their prey before swallowing.

If we examine the lateral and intercostal muscles of one of the large Pythonoid snakes, we shall find that although these are very highly developed, and have indeed in certain instances small tendenous slips attaching them to the ribs, which are not found in smaller species, they are precisely analogous to the ordinary intercostal muscles which obtain through the whole of this family.

In certain species, such as the Milk snakes of the Northern states, and the Mandarin snake of China, we may occasionally see, when they are dealing with prey rather too strong for them, a sort of attempt made at constriction, a rapid coiling and uncoiling of the body, as though to confuse the animal struggling within the grasp of the jaws and teeth. And it is perhaps not wholly unjustifiable to imagine that this power of constriction may originally have been acquired in this way ; that serpents which had previously fed, as our ordinary Colubrine snakes do, upon frogs, lizards, and soft-bodied animals which they could kill by pressure of the jaws alone, found themselves, for some reason or other, reduced to catching the smaller mammalia, mice, moles, etc., and that in their endeavors to get these within the cavity of the mouth, they found it necessary to bring the body into play to effect the purpose which had hitherto been accomplished by the jaws alone. One may, however, express the hope that when larger materials are at hand for examination, in the shape of the grander Pythonoid snakes, and most especially of the great Water Boa, the Anaconda of Central America, that some more definite information on this point will be gleaned.

NOTES AND NEWS.

AT a recent meeting of the Canadian Institute, Mr. Andrew Elvins asked permission to add a sentence or two to his paper on the satellites of Jupiter, read at a former meeting. He said: "The period of each satellite as we pass outward from the planet is about double that of the one next inside itself, except in the case of Satellite I. Half its period would be about 21 hours, but there is no satellite having that period. Half of this 21-hour period is just where Professor Barnard's new satellite exists. Its period is between 11 and 12 hours. I therefore think that an undiscovered sixth satellite exists at 166,000 miles from Jupiter's centre, with a period of 21 hours."

—The faculty of the Museum of Comparative Zoölogy, Cambridge, Mass., will receive applications from candidates desiring to occupy the table at the Naples Zoölogical Station, which has been placed at its disposal from Oct. 1, 1893. The applicant must be (or have been recently) a student or instructor at some American university, preferably a person who has taken the degree of Ph.D. or S.D. ; he must have published some creditable original investigation, and should be recommended as an able investigator by the professor under whom he has studied. Applicants will please forward to Professor Alexander Agassiz, Director of the Museum, before May 10, their recommendations and a statement of their qualifications and of the subject to which they hope to devote themselves. In order that the faculty may make the most satisfactory disposition of the table during the whole year, the applicants are requested to state the length of time they desire to remain at Naples, and also the earliest and latest dates within which they can avail themselves of the appointment. The faculty will, at its meeting in May, nominate to the Corporation of Harvard College for approval the incumbent or incumbents for the year 1893-94.

—The papers entered to be read at the April meeting of the National Academy of Sciences, are as follows: On the Systematic Relations of the Ophidia, E. D. Cope ; Biographical Memoir of General Montgomery C. Meigs, H. L. Abbott ; On the Nature of Certain Solutions, and on a New Means of Investigating Them, M. C. Lea; The Relations of Allied Branches of Biological Research to the Study of the Development of the Individual, and the Evolution of Groups, The Endosiphonoidea (Endoceras, etc.) Considered as a New Order of the Cephalopods, A New Type of Fossil Cophalopods, Results of Recent Researches upon Fossil Cephalopods of the Carboniferous, A. Hyatt ; Biographical Memoir of Julius Erasmas Hilgard, E. W. Hilgard; Monograph of the Bombycine Moths of America, North of Mexico: Part I.—Notodontidæ, A. S. Packard; Intermediary Orbits, G. W. Hill; The Relations between the Statistics of Immigration and the Census Returns of the Foreign-born Population of the United States, Statistical Data for the Study of the Assimilation of Races and Nationalities in the United States, Richmond Mayo-Smith; Telegraphic Gravity Determinations, Comparison of Latitude Determinations at Waikiki, T. C. Mendenhall; A One-volt Standard Cell, H. S. Carhart (introduced by T. C. Mendenhall); Fundamental Standards of Length and Mass, T. C. Mendenhall; Peptonization in Gastric Digestion, R. H. Crittenden ; Helen Kellar, Alexander Graham Bell; On a Potentiality of Internal Work in the Wind, On a Bolograph of the Infra-red Solar Spectrum, S. P. Langley; The Classification of the Gastropodous Mollusks, Theo. Gill. Presentation of the Draper Medal to Professor H. C. Vogel.